

ARMY SCIENCE BOARD

2001 SPECIAL STUDY

FINAL REPORT



DEPARTMENT OF THE ARMY
ASSISTANT SECRETARY OF THE ARMY
(ACQUISITION, LOGISTICS AND TECHNOLOGY)
WASHINGTON, D.C. 20310-0103

“MANPOWER AND PERSONNEL FOR SOLDIER SYSTEMS IN THE OBJECTIVE FORCE”

June 2001

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CONFLICT OF INTEREST

Conflicts of interest did not become apparent as a result of the Panel’s recommendations.

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| The Army Science Board was tasked to analyze future Soldier Systems in the 2001 Summer Study "Objective Force Soldier / Soldier Team". This Manpower and Personnel Special Study was developed to support that primary Study by assessing Manpower and Personnel related issues. Taskings specific to this Special Study include: 1) Investigate the demographic characteristics of soldiers in 2015 and assess their capabilities; 2) Investigate the projected Knowledge, Skills and Attributes (KSA) required for Future Combat Systems tasks and assess the match/mismatch between the projected skill set of soldiers and required skills based on FCS tasks; 3) Assess the Army R&D that is going on in the manpower and personnel area and investigate university/industry R&D in the manpower and personnel area. Major study recommendations include: 1) Create and validate a new selection measure (e.g., revise ASVAB); 2) Improve the match of the Knowledge, Skills and Attributes of available Objective Force Soldiers with available positions; 3) Analyze the cost effectiveness of the various well-being initiatives to improve retention; 4) Develop virtual distributed Man-in-the-Loop simulations for personnel life cycle functions. | | | | |
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2001 SPECIAL STUDY

FINAL REPORT

**“MANPOWER AND PERSONNEL FOR
SOLDIER SYSTEMS IN THE
OBJECTIVE FORCE”**

June 2001



In memory of LTG Timothy J. Maude,
Deputy Chief of Staff for Personnel,
who lost his life in the terrorist attack
on the Pentagon, 11 September 2001.

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**Army Science Board Special Study:
Manpower and Personnel
for
Soldier Systems
in
The Objective Force**

Final Report: June 25, 2001

**Co-Chairs: BG(R) Jim Ralph and Dr. Harry O'Neil
Cognizant Deputy: Dr. Bob Holz**

PENDING PUBLIC RELEASE

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The Army Science Board (ASB) 2001 Summer Study was titled "Objective Force Soldier / Soldier Team." The Manpower and Personnel Study was one of several Special Studies conducted in FY01 in support of the Summer Study. This study was also a follow-on study for the 2000 Summer Study called "Technical and Tactical Opportunities for Revolutionary Advances in Rapidly Deployable Joint Ground Forces in the 2015-2025 Era." The 2000 Study Report is available on the ASB Web site (www.saalt.army.mil/sard-asb/).

This brief provides our final report for the Special Study. Version 8 reflects the input of the red team 16-17 May 2001 at 3rd plenary session. Version 9 reflects the input of the other sponsor, LTG Timothy Maude, DCSPER, briefed on 19 June, 2001. He indicated that he would use the study to support manpower and personnel R&D requests. He will issue instructions for its support, distribution and implementation.



WHAT IS THE OPERATIONAL VALUE OF GOOD SOLDIERS?



AGDMF 3 May 01 v3 - SKM

ASDMF 19 June 01 v5A - Slide 2

The nature of this equation is that Weapons Systems capability times People capability equals War Fighting capability. Thus, if People capability is little or zero, then War Fighting capability is also zero, as Weapon Systems capability \times 0 People capability = 0 War Fighting capability.

"The Army is quality soldiers, veterans, civilians, and our families...Our physical, moral, and mental competence will give us the strength, the confidence, and the will to fight and win anywhere, anytime." (The Army Vision (2001), www.army.mil/armyvision).

The Army Vision



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- Sponsors
- Terms of reference
- Background of study
- Results of study (TOR 1, TOR 2, TOR 3)
- Recommendations
- What we want you to remember

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SPONSOR

- THE DCSPER — LTG TIMOTHY MAUDE¹
- ADCSPER — MG GEOFFREY MILLER

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- 1 We met with MG Miller, ADCSPER, early in the study. He provided advice/council on this study effort which we, in turn, have implemented in this report.

We also briefed LTG Maude, the DCSPER, on June 19, 2001. He found the brief “exciting,” and he offered his full support for the recommendations.



TERMS OF REFERENCE—SIMPLY STATED

- **MANPOWER AND PERSONNEL**

- I. Demographic Characteristics:
 - Who Will Be Available?
 - What Attributes Will They Have?
- II. Attribute Requirements:
 - What Knowledge, Skills, Attributes Will Be Needed?
- III. Research and Development Requirements:
 - Is R&D Effort Adequate To Permit the Army to Acquire, Assign, and Sustain Personnel for the Objective Force?

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The formal Terms of Reference (TOR) can be found in Appendix A. The chart above provides an outline of the TOR.

The Army DCSPER fully supported this Special Study to investigate these issues and whether there is adequate funding for 6.1, 6.2, and 6.3A programs in this area. Such funding should provide for appropriate research in soldier qualifications, skills, knowledge, attitudes etc., to meet quality, quantity, and ethnic and gender diversity to fill Army requirements for FCS in 2010-2025.

This Special Study supported the 2001 Summer Study, “[The] Objective Force Soldier / Soldier Team,” chaired by Dr. Bob Douglas.



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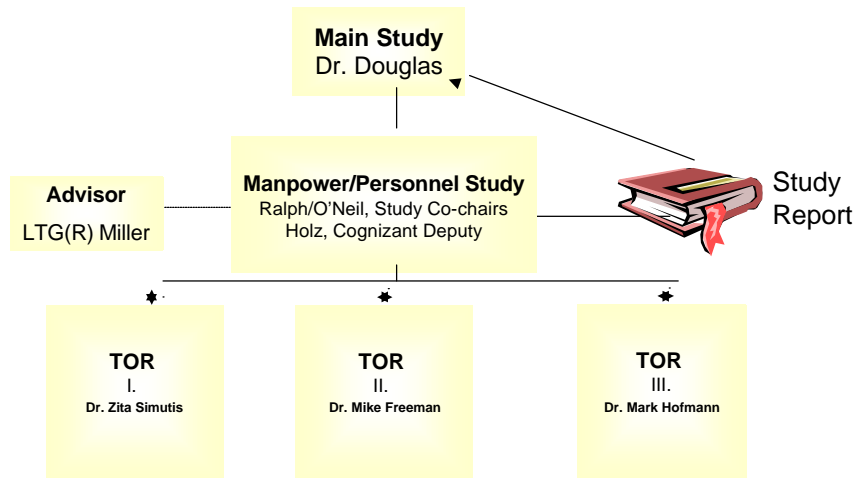
COL BRUCE WESTCOTT
Deputy Chief Army Reserves

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There was a good mix of active and retired military, industry and academic, and U.S. Army civilians on this Special Study. The members are listed alphabetically. Further, there was representation from both the National Guard (COL(P) Dave Raes), the Army Reserves (MG Sue Dueitt), OCAR (Col. Ron Logsdon).



STUDY ORGANIZATION



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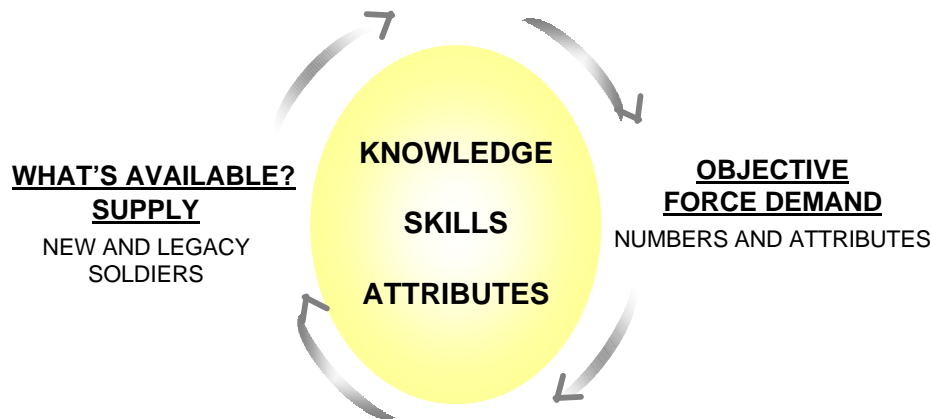
The study organization involved a standard approach to managing a Special Study. The purpose of the Special Study was to inform the Main Study, headed by Dr. Bob Douglas, of relevant manpower and personnel issues impacting the Objective Force. Our deliverable was this brief with notes (i.e., the Study Report).

We organized ourselves into three groups with responsibilities for each of the Terms of Reference, headed by Drs. Simutis, Freeman, and Hofmann respectively. We were also informed by a Special Advisor, LTG(R) Miller, to the Manpower/Personnel Study Leadership (BG(R) Jim Ralph, Dr. Harry O'Neil, and Dr. Bob Holz).



STUDY SCHEMATIC

HOW MANY ARE NEEDED WITH WHAT KSAs?



HOW WILL WE ACQUIRE, ASSIGN AND SUSTAIN THEM?

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The conceptual framework for the study starts on the right with the demand side of the equation. Demand, in terms of numbers, is strength requirement driven. On the other hand, demand is driven not only by the number of jobs but also by the types of jobs. Thus, at the top, “How many are needed with what KSAs?” represents the desired parameters for “Knowing what we would like to have”. This serves as the basis for recruitment and incentive activities. Still moving counter-clockwise we reach “What will be available?” This question embraces a KSA’s perspective as well as a demographic perspective, i.e., our Objective Soldier Supply. In this supply mix, we must consider legacy soldiers or those which are already on board, as well as those provided by recruitment efforts. The final step is “How to best access or acquire from the supply pool to achieve best job match or assignment?” Also, to identify those factors that will motivate and provide a sense of well being. The ability to achieve the “best job match” will reduce attrition and training costs. It will increase job performance and job satisfaction. Combining good job match with well-being factors will also reduce attrition, enhance performance, improve retention and increase morale. Having said this: “Are there adequate Tech Base resources to produce valid tools, techniques and knowledge to answer the questions posed in the schematic?”

In summary, this is a model for acquiring, assigning and sustaining soldiers for the Objective Force. The model highlights the need to:

- Estimate the number of soldiers and the attributes they must have to meet Objective Force requirements.
- Assess the availability of civilians and Legacy Force soldiers having these attributes.
- Evaluate Army capability to meet Objective Force requirements with qualified soldiers.



TERMS OF REFERENCE (1)

- “Investigate the demographic characteristics of the soldier in 2010–2020, e.g., quantity, quality, ethnic distribution, gender distribution.”

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- While future population demographics are not explicitly requested in TOR1, projecting soldier demographics requires comparable civilian information. This information was based on Census Bureau and National Center for Education Statistics reports.
- The TOR was interpreted as a task:
 - (1) to compare civilians and Army populations across demographic variables with an emphasis on quality-related demographics, over time using historical data and future projections, and
 - (2) to identify emerging policy and research needs.



DEMOGRAPHIC CHARACTERISTICS

• TOR1: Demographic Projections

- Minority youth population will increase, especially Hispanics.

Projected change by 2015 relative to 2001:

- Black = 12.6% increase
- Hispanic = 44.2% increase
- Total = 8.3% increase
- White = -2.8% decrease

- Army is becoming:

- Older:
- More racially diverse
- Gender diverse

| | AC | | RC | |
|--------------|------|------|------|------|
| | 1980 | 2000 | 1980 | 2000 |
| Age | 25.6 | 28.0 | 29.7 | 34.0 |
| % Minority | 37.7 | 41.6 | 28.0 | 31.8 |
| % Hispanic | 4.0 | 8.3 | 6.0 | 7.8 |
| % Female-Enl | 9.1 | 15.6 | 8.2 | 16.2 |
| % Female-Off | 7.7 | 14.0 | 7.1 | 17.1 |

- Parental family structure becoming less traditional

| Percent <u>all</u> children (0/17) in: | | | | | | Percent Older Teens (15/17) in 1996 with: | |
|--|------|------|------|------|--|---|--|
| 1970 | 1980 | 1990 | 1998 | | | - 2 Biological Parents (incl 2 adoptive) = 54.9 | |
| - Two Parent Home | 85.2 | 76.7 | 72.5 | 68.1 | | - 1 Biological & 1 Step parent = 11.5 | |
| - One Parent Home | 11.9 | 19.7 | 24.7 | 27.7 | | - 1 Biological & no step parent = 27.7 | |
| - Other | 2.9 | 3.6 | 2.8 | 4.2 | | - No parental presence = 6.0 | |

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There is consistent agreement among demographers that minority populations will increase in the United States, especially Hispanics (U.S. Department of Commerce, Bureau of the Census, Current Population Reports, Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050 (P25-1130)).

For data available through 2000, it is clear that the Army has become older and more racially and gender diverse. These analyses were conducted by (1) the Defense Manpower Data Center and (2) the Office of the Duty Chief of Staff for Personnel). It is expected that such trends will continue to reflect changes in the population (Hispanics) and in Army policy (gender & age).

Since 1970, family structure has become less traditional, i.e., two married parents with their own biological children. The parental family trends [left box] are based on current populations survey data: U.S. Department of Commerce, Bureau of the Census, Current Population Reports Population Characteristics, Marital Status and Living Arrangements 1994 and 1998 (Update), (P20-484).

The description for Older Teens Family Structure estimates can be found at www.childstats.gov/ac2000/pop5b.htm and reflect *Survey of Income and Program Participation* (SIPP) data. A recent census bureau report indicates that this phenomenon may have bottomed out. As reported in *USA Today* (Fri/Sat/Sun, April 13-15, 2001, p. 1), the percentage of children living with married biological parents has risen from 51% in 1991 to 56% in 1996. (Original Source: Census Bureau Living Arrangements of Children 2001 Study, www.census.gov)

Each survey defined nuclear family somewhat differently.

The important conclusion to be drawn from these data is that a substantial proportion of youth will continue to live in non-traditional settings.

For the time period 2015, there are no Army or RAND or Army Research Institute projections. There is a RAND report that had information on 2025 (Orvis, Nichipourk, MacDonald, Quigley & Sastry (August 1998) Future Personnel Resource Management: Initial Report, Rand Corporation Report Number AB-210-1-A)).



DEMOGRAPHIC CHARACTERISTICS (Cont.)

- A third grader now will be entering the Army in 2010
- Compared to previous generations:
 - Is more likely to be a minority group member
 - Shows slightly greater academic achievement
 - Compares very favorably academically to children from other nations
 - Is familiar with technology
 - Is likely to be heavier
 - Is more likely to be a high school graduate and attend college
 - Is likely to have higher propensity for military service if Hispanic
 - Is more likely to live in a non-intact family structure

| Prevalence of Obesity - Young Children (6/11) | | | |
|---|------|------|------|
| 1972 | 1978 | 1990 | 1999 |
| 4% | 7% | 11% | 13% |

| Percent Positive Military Enlistment Propensity by Race/Ethnicity/Gender - 1999 | | | |
|---|---------|-----------|-----------|
| | White | Black | Hispanic |
| Male/Female | 9.3/3.7 | 16.3/10.9 | 12.4/20.5 |

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This slide highlights differences between current youth who may enter the military in 2010 and previous generations. Citations linked to topics:

- Minority representation: U.S. Department of Commerce, Bureau of the Census, Current Population Reports, Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050 (P25-1130).
- Academic Achievement: U.S. Department of Education. Office of Educational Research and Improvement. National Center for Education Statistics. NAEP 1999 Trends in Academic Progress: Three Decades of Student Performance (NCES 2000-469). By J. R. Campbell, C. M. Hombo, & J. Mazzeo. Washington DC: 2000.
- International Comparisons: Mullis, I. V. S., Martin, M. O., Beaton, A. E., Gonzalez, E. J., Kelly, D. L., & Smith, T. A. (1998, February). Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study (TIMSS). International Association for the Evaluation of Educational Achievement, TIMSS International Study Center, Chestnut Hill, MA.
- Technology Familiarity: U.S. Department of Education, Office of Educational Research and Improvement, Digest of Educational Statistics (NCES 2001-034).
- Obesity trends: National Center for Health Statistics - www.cdc.gov/nchs/products/pubs/pubd/hestats/overwght99 [note: link outdated on 6-27-2001]
- High School & College Graduation: U.S. Department of Education, Office of Educational Research and Improvement, Digest of Education Statistics 2000 (NCES 2001-34); U.S. Department of Education, National Center for Educational Statistics: www.nces.ed.gov/pubs2000/projections
- Propensity by Race: ODCSPER Demographic Office in HR.
- Family Structure: U.S. Department of Commerce, Bureau of the Census, Current Population Reports Population Characteristics, Marital Status and Living Arrangements 1994 and 1998 (Update) (P20-484); See also www.childstats.gov/ac2000/pop5b.htm.



DEMOGRAPHIC CHARACTERISTICS (cont.)

- By the 12th grade in 2010, he or she will be
 - Showing equivalent academic achievement to earlier generation U.S. 12th graders
 - National Assessment of Educational Progress trends
 - As in past, comparing very unfavorably academically to children from other nations
 - Third International Science and Mathematics Study data indicate above-average 4th graders, average 8th graders, almost dead last 12th graders when compared to students in other countries

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This slide continues to describe expected youth in 2010.

- Academic Achievement: U.S. Department of Education. Office of Educational Research and Improvement. National Center for Education Statistics. NAEP 1999 Trends in Academic Progress: Three Decades of Student Performance, NCES 2000-469, By J. R. Campbell, C.M. Hombo, & J. Mazzeo. Washington DC: 2000.
- International Comparisons: Mullis, I. V. S., Martin, M. O., Beaton, A. E., Gonzalez, E. J., Kelly, D. L., & Smith, T. A. (1998, February). Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study (TIMSS). International Association for the Evaluation of Educational Achievement, TIMSS International Study Center, Chestnut Hill, MA.
- Marty Orland, email to Harry O'Neil, 3/30/2001.



SKILL SUMMARY

- **Skill Level Projections**

- Academic achievement will change very little from 2001 to 2010
 - NAEP scores have increased less than .20 standard deviation units across all testing domains since 1980
- Technology familiarity will increase due to home and school computer use
- AFQT scores will remain stable from 2001 to 2010
 - Since 1985, Mean AFQT has ranged from 57.79 to 59.32, only 1.53 points
- High school graduation and college continuation rates will remain high in 2010
 - Current high school graduation rates are 93.0% (white) and 88.7% (black). A lower Hispanic rate, 61.6%, may reflect recent immigration
- Bottom Line: Potential recruits will be similar in skills to today's recruits

Percent students using computers:

| | 1984 | 1989 | 1993 | 1997 |
|-----------|------|------|------|------|
| At school | 27.3 | 42.7 | 59.0 | 68.8 |
| At home | 11.5 | 18.8 | 27.0 | 45.1 |

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This chart summarizes changes in the cognitive characteristics and skills that civilian youth are likely to have as they enter the Army through 2010. On the basis of NAEP test performance data and AFQT recruit trend data, it is expected that the youth population and new recruit cohorts will change very little in terms of either general academic achievement or general cognitive aptitude. Educational enrollment data are consistent with this expectation and indicate that a high proportion of the youth population will continue to graduate from high school. However, youth are likely to be much more technologically savvy because the presence of computers in home and educational settings has dramatically increased.

Citations linked to topics:

- Academic Achievement: U.S. Department of Education. Office of Educational Research and Improvement. National Center for Education Statistics. NAEP 1999 Trends in Academic Progress: Three Decades of Student Performance (NCES 2000-469). By J. R. Campbell, C.M. Hombo, & J. Mazzeo. Washington DC: 2000.
- Technology Familiarity: U.S. Department of Education, Office of Educational Research and Improvement, Digest of Educational Statistics (NCES 2001-034).
- AFQT: Analyses based on enlisted accession datafiles maintained at ARI since 1973
- High school and college continuation rates: U.S. Department of Education, Office of Educational Research and Improvement, Digest of Education Statistics 2000 (NCES 2001-34).



TERMS OF REFERENCE (2) PROJECTED SKILLS AND MATCH/MISMATCH

- Investigate the projected knowledge, skills, attributes for Future Combat Systems tasks
- Assess the match/mismatch between the projected KSA (skill) set of soldiers and required skills based on FCS tasks. Characterize the 5th, 50th, and 95th percentiles of required skills?

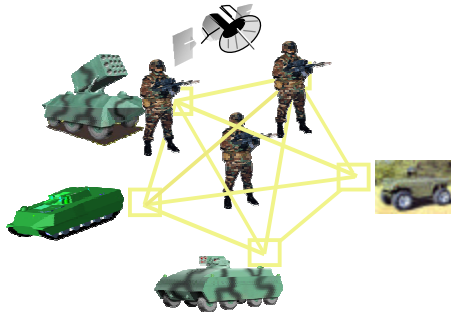
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These are the terms of reference that address the requirements for future soldiers. The focus of these TOR was to first determine the general soldier knowledge, skills and attributes required for objective force soldiers and, specifically, FCS tasks. The second focus of the TOR was to compare the projected soldier requirements with the projected recruit qualities derived from the first two TOR. This comparison was conducted to develop an assessment of the match/mismatch between what is projected to be required and what is projected to be available. Although not addressed in the scope of this study, the difference between required and available knowledge, skills and attributes must be remedied through training, selection, etc. in order to provide the right soldier for the job. It's important to keep in mind that, due to the unique role and culture of the Army, there will always be mismatch between the qualities of the recruit population and the qualities of a successful soldier.



OBJECTIVE FORCE

Distributed, internetted, collaborative team of teams engaging in very complex tasks



Tenets

- **See First**
- **Understand First**
- **Act First**
- **Finish Decisively**

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Initial projections indicate that a single command and control station with multiple robotic weapons platforms and a crew of four could cover a 10-kilometer front, an area that now requires a 100-man tank company.

<http://www.ausa.org/armyzine/gourleyjuly00.htm> **[not working on 6-27-2001]**

In the dynamic battlefield environment of the future, C4ISR functions will be critical to the FCS success. The blinding speed and sheer volume of information will overwhelm and inundate the FCS operators and decision-makers. The information must be integrated and filtered (fused) appropriately.

Sensor-to-shooter operations will become increasingly complex and will pose formidable training challenges. Extensive knowledge and substantial inferential capability are required to interpret sensor data, generate hypotheses about their meaning, and propose courses of action, particularly when multiple sensors, weapons, and tactical situations are involved. All of these tasks require deep understanding of

the functional properties being sensed, the operation and limitations of sensors, and the environmental or real-world interactions that affect data observation and interpretation. Further complexity is encountered in most warfare applications as intelligent opponents seek to avoid detection, confuse identification, and gain tactical advantage by employing intelligent countermeasures or unconventional maneuvers to make sensor employment even more difficult. (ASB 2000)



EXAMPLES OF VERY COMPLEX TASKS

- Manage C2 of direct and indirect fire robotic systems
- Conduct teleoperated robotic navigation
- Control anti-jamming networks
- Ensure network security for C2 of distributed robotic systems
- Control robotic sensors

~15% of tasks can be described as very complex

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This information is from the Training Panel of the Army Science Board report O'Neil, H. F., Jr., Drenz, C., Lewis, F., et al. (2000), *Technical and Tactical Opportunities for Revolutionary Advances in Rapidly Deployable Joint Ground Forces in the 2015-2025 era*. Army Science Board-1999-2000 Summer Study.

Shown on this chart are examples of very complex tasks. For a verbal transition the briefer could allude to naval sonar tasks. The tasks are modified from a draft concept paper by Terry D. Faber, Army Training Support Center, Enhanced Embedded Training, 7/14/00. In this scenario, an operator determines where high-speed robots must navigate and chooses anti-jamming frequencies and networks based on recent intelligence information. While controlling the robotic system, the operator must assess information from other sensors supporting the operation as to reliability and counter measures effects. The operator must also select responses with other operators while also performing Battlefield Defense/Damage Assessments (BDA) and responding appropriately. (ASB 2000)



LINKING SPECIAL FORCES KSAs WITH THE OBJECTIVE FORCE

- To link these and other KSAs with the Objective Force needs, a critical first step is to identify the nature of possible similarities between Special Forces and the Objective Force, for example:
 - Organizational structure: e.g. operating in small units with low levels of supervision
 - Situational conditions: e.g. high stress, high visibility
- 10 KSAs ranked as the most important to the overall SF mission are:
 - Team playership
 - Maturity
 - Judgment/decision-making
 - Dependability
 - Adaptability
 - Cultural/interpersonal adaptability
 - Physical endurance
 - Initiative
 - Perseverance
 - Autonomy

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FCS teams will look something like the Special Forces in terms of mission/roles/ skills. The KSAs for the Special Forces can be found in the following citations:

Zazanis, M. M., Kilcullen, R. N., Sanders, M.G., & Crocker, D.A. (1999, Summer). Special Forces selection and training: Meeting the needs of the force in 2020. Special Warfare, 12(3), 22-31.

Brooks, J. E., & Zazanis, M. M. (Eds.). (1997, October). Enhancing U.S. Army Special Forces: Research and Applications (ARI Special Report 33). Alexandria, VA: Army Research Institute.

Such skills may require a new Armed Services Vocational Aptitude Battery (ASVAB).



KNOWLEDGE, SKILLS AND ATTRIBUTES HIGHER REQUIREMENTS FOR FCS THAN CURRENT FORCE

- **Currently part of ASVAB**
 - General Science, Arithmetic Reasoning,
 - Electronic Information, Coding Speed, Numerical Operations
- **Not currently measured**
 - Dynamic Visualization/ Pattern Recognition
 - Collaboration/Teamwork
 - Adaptability/Creativity
 - Situational Awareness
 - Conscientiousness/Dependability
 - Technological Fluency
 - Team Competencies

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The definitions of the KSA's can be found in Appendix D.



KSA MATCH/MISMATCH

- Assess the match/mismatch between the projected skill set of soldiers and required skills based on FCS tasks.
- Can we characterize the 5th, 50th, and 95th Percentiles?

Most of KSAs are not addressed by current measures.
– Will have to be created, Thus:

Cannot characterize the 5th, 50th, 95th percentiles without further research in measures.

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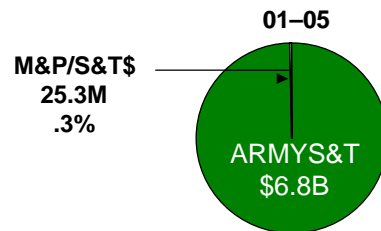
The main utility of determining the knowledge, skills and attributes (KSAs) available in the projected recruit population and comparing them to KSAs required for FCS tasks/objective force soldiers was to highlight match/mismatch between the two. However, we found that most of the KSAs we projected are not addressed by current measurements. Further, we expect that such KSAs for the National Guard and Army Reserves may be different from their active duty counterparts, considering the limited time for training and the impact of a forgetting curve between training sessions. Therefore, we couldn't reliably determine match/mismatch, nor characterize the distribution of soldiers, with the required KSAs. This means appropriate measurements will have to be created, validated and implemented before characterization of the population or decisions on appropriate policies and treatments. At suggestion of Mr. Michael Bayer (ASB Chair) we looked at the change in height for male soldiers since the civil war. Dr. Claire Gordon, Senior Anthropologist at the U.S. Army Natick Soldier Center, provided the information in a report on males 1865-1988. Height has remained relatively constant. For example, in 1865 it was 67.6 inches whereas in 1988 it was 69.1 inches or a growth of 1.5 inches for the time period. The height varied among various ethnic groups.



MANPOWER & PERSONNEL/SCIENCE & TECHNOLOGY (TOR 3)

The question:

Is M&P/S&T funding adequate to provide research-based tools, techniques, procedures and information needed to meet the soldier acquisition, assignment and sustainment requirements of the objective force?



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GOOD NEWS

- M&P/S&T efforts ongoing and planned are solid but will not meet the needs of the Objective Force.
- Time is available to conduct M&P/S&T to meet the needs of the objective force — must start now!

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The Special Study reviewed Manpower & Personnel research conducted at the Army Research Institute. The following Program Elements (PE) were reviewed: Manpower, Personnel and Training (62785) and Manpower Personnel and Training Advanced Technology (63007). Our judgment was that the ongoing and planned R&D efforts are solid and on-track.

The vast majority of the R&D efforts that we suggest require no new breakthroughs in basic behavioral social science research and technology. There is sufficient basic research (6.1) to have the confidence to conduct the applied R&D (6.2/6.3). The cycle time for such research is within the needed requirements if started ASAP.



GOOD NEWS (Cont.)

- For cost savings, small changes lead to big savings due to size of manpower savings pool
- Back of envelope calculation indicates potential 5 year savings of 175m if 5% cut in attrition rates = \$175m¹
- Multiply number of accessions X attrition rate X cost of each attrit to get estimated annual costs associated with attrition, e.g., 71,749 X .368 X 27,255=\$719,639,935
- Estimate potential impact of 5% reduction, e.g., 718m X 5% X 5yrs.=175 m
- Improved readiness and combat effectiveness

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¹The average cost of recruiting and training a soldier is approximately \$27K. Does not include replacement costs. Costs are not net present value. A reduction of 5% in the attrition rate, using the FY98 accessions figures, would result in 1325 fewer attritees.

Approach:

- 1) *Step One: Calculate the number of soldiers who access each year, e.g., FY98 Accessions: 71, 749 (includes 66,442 non prior service accessions and 5,307 prior service accessions.*
- 2) *Step Two: Calculate the rate of attrition over a full term of service, e.g., Projected 36 month attrition rate for FY98 cohort: 36.8% (data from First Term Enlisted Attrition Council of Colonels Steering Committee, 28 April 1999, based on Feb 99 data).*
- 3) *Step Three: Calculate the cost of each attrit, e.g., recruiting cost: \$16,644, Training costs:\$10,611 (13,264 reduced by half the cost of attrition occurring during training) Total costs:\$27,255 (includes average costs; does not account for additional marginal costs. Costs based on AMCOS data accessed in Dec 1998.*
- 4) *Step Four: Multiply number of accessions X attrition rate X cost of each attrit to get estimated annual costs associated with attrition, e.g., 71,749 X .368 X 27,255=\$719,639,935.*
- 5) *Step Five: Estimate potential impact of 5% reduction, e.g., 718m X 5% X 5yrs.=175 m*

The above data were provided by ARI. GAO testimony (2/24/2000) on the issue is consistent with these data.

Their summary indicated while many of their initiatives appear promising, the latest 4-year attrition data available, for those who entered the services in fiscal year 1994 and left by the end of fiscal year 1998, indicate that this rate continued to rise and currently is at an all-time DOD high of 36.9 percent.

Military Personnel: First Term Recruiting and Attrition Continue to Require Focused Attention. Statement for the Record of Norman J. Rabkin, Director, National Security Preparedness Issues, National Security and International Affairs Division (GAO/T-NSIAD-00-102). Released February 2000.



BAD NEWS

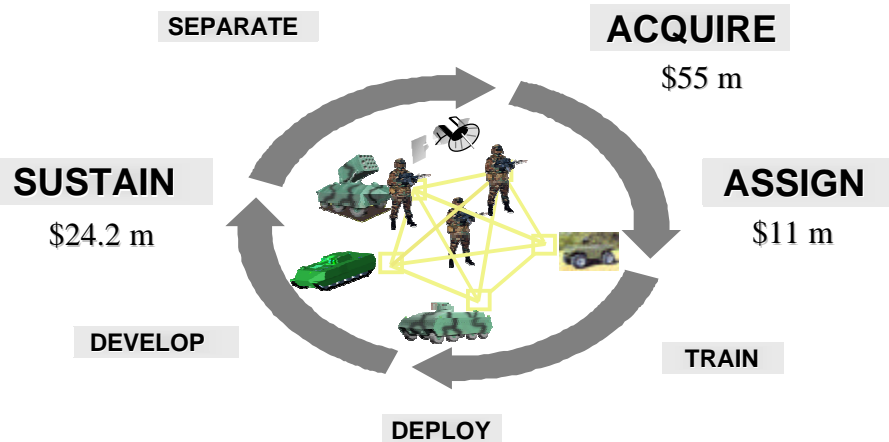
- Little relevant industry or academic research exists¹
- Lots of opinion but little hard data on what skills will be needed, how to best assign those recruited, and what factors will sustain
- Need to fund R&D — add an additional \$150M in POM cycle

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¹ ARI has comprehensively reviewed over 400 available industry and academic research documents on future requirements. Almost no work was found that scientifically addressed the issues of future skills, future assignment or future sustainment. Neither the Air Force or the Navy is systematically addressing these questions. There is much speculation within the Army on future skill requirements. Research conducted by ARI is developing methods to quantify future skill requirements and has attempted to quantify the future skill requirements of NCOs. This work was restricted to NCOs, and then only generic NCO skills because of funding limitations. These methods will be refined in 02 to 05 to predict generic skills required for first tour Objective Force soldiers. The work will only be applied to generic skills, again because of funding limitations.



SOLDIER LIFE CYCLE FOR TOTAL ARMY¹



To improve life cycle \$60 m

¹ Active, Reserve, National Guard, Civilian

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Regarding the personnel life cycle functions, AR 600-3 (2.16) specifies the three functions our panel was concerned with (www.usapa.army.mil). Consistent with what the AR says, we know that acquire primarily relates to recruiting; assign matches faces to the spaces in the force structure; and sustainment relates to retentions efforts like quality of life and well being. We have adopted ARI's Soldier Life Cycle model as useful for focusing R&D issues (ARI 2001 Work Program). This model, although slightly different in terminology and function, is consistent with the Army Regulation. In our graphic, ACQUIRE is consistent with Acquisition in the regulation, ASSIGN is consistent with Distribution in the regulation, and SUSTAIN is consistent with Sustainment in the regulation.



TO IMPROVE THE ACQUIRE PROCESS

- Create and validate new selection measure (\$50M)¹
 - Validate skills required by FCS tasks via cognitive task analysis
 - Identify leader tasks vs. soldier tasks
 - Project youth population skill levels in relation to soldier requirements
 - Revise ASVAB to measure skills including working with robots
 - Validate ASVAB against FCS simulated tasks
 - Need performance assessment measures (a la SQT/ARTEP)
- Determine the cultural characteristics of Latinos that would improve ACQUIRE/ASSIGN process? (\$5M)²
- Possible action agency ARI

POM increase = \$55M for ACQUIRE R&D

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¹ The R&D required for creation and validation of new selection measures would be similar, in regard to goals, to Project A in the 1980s for process and costs.

The methodology would be cognitive task analysis. One would thus create new tests for the ASVAB (e.g., dynamic visualization). Such tests would be administered to Army enlisted personnel along with FCS simulated tasks. Measures for both individual and collective proficiency would have to be created. These new measures would be administered at the same time as the ASVAB. One would validate the new ASVAB by seeing whether new tests predict performance on new measures of FCS simulated tasks.

² The greatest increase in potential recruits will be in the Latino community. Little is known about cultural characteristics affecting enlistment.



TO IMPROVE THE ASSIGNMENT PROCESS

- Match KSA of available Objective Force soldiers to available Objective Force jobs
 - Use new assignment process with existing ASVAB (\$10M)
 - Use new assignment process with revised ASVAB, e.g., simulation (\$1M)¹
- Possible action agency ARI

POM increase = \$11M for ASSIGN R&D

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¹ This work would start Year 5 as ACQUIRE R&D then transition to ASSIGN R&D in year six and be completed Year 9. This would require additional funds in the second POM cycle.

The current assignment system links ASVAB tests with existing jobs. As jobs change, the assignment system must change as well. The ASVAB tests that are most predictive of performance of specific Objective Force jobs or sets of jobs need to be identified. This will require extensive research linking ASVAB tests with measures designed to represent performance in future jobs.

As noted earlier in this presentation, current ASVAB tests only partially represent knowledge, skills, and attributes that will be required for effective performance in the future. As a revised ASVAB is developed which more completely measures KSAs needed for success on Objective Force jobs, research to link the new ASVAB test with performance on these jobs will be needed to develop an assignment process which fully utilizes the new ASVAB.



TO IMPROVE THE SUSTAINMENT PROCESS

- Validate cost-effectiveness for alternative well-being factors¹ (\$15M)
 - Determine how educational opportunities provided by the Army impact the skill level, commitment, and attrition of the force
- Validate motivation measures for distance learning² (\$5M)
- Examine how the changing ethnic and gender composition impacts outcomes important to the Army (e.g., cohesion, cultural tolerance, attrition)³ (1.2M)
- Establish factors needed to trust in robots/ automation⁴ (\$3M)
- Possible action agency ARI

POM increase = \$24.2M for SUSTAIN R&D

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- ¹ There are many possible well-being interventions, e.g., on-duty education vs. family housing. What is needed is software modeling tools that would permit trade-offs based on cost-effectiveness criteria of these various options.
- ² Both the Army university online program and TRADOC's Distance Learning program attrition rates are expected to be higher, based on experiences with civilian distance learning systems (Phipps R., & Merisotis, J., 1999). What's the difference? A review of contemporary research on the effectiveness of distance learning in higher education. Report prepared at the Institute for Higher Education Policy.
- ³ Determine how changing demographics impact cohesion, tolerance and attrition will provide insight to manage the force as it becomes increasingly diverse. For example, more diverse cultural experiences may increase knowledge and awareness of minority groups and may impact tolerance, improve cohesion and lower attrition. Related policy should be responsive to the projected growth of various minority groups.
- ⁴ A major reason soldiers fight is trust in their buddies, not factors like patriotism. In automated systems, a major requirement for trust is reliability.



TO IMPROVE TOTAL SOLDIER LIFE-CYCLE FOR FCS

- Develop trade-off models for: Manpower and Personnel vs. Training vs. Human factors vs. medical in terms of capabilities and cost (\$10M)¹
 - Let's select smarter soldiers vs. Training (let's train smarter soldiers) vs. Human factors (let's design the interface for less smart soldiers) vs. Medical (let's develop a smart pill)
 - Possible action agency ARI
- Develop virtual, distributed, man-in-loop simulations for ACQUIRE, ASSIGN, and SUSTAIN functions (\$25M)²
 - Possible action agency STRICOM
- Develop HR Scorecard for the Army (\$5M)³
 - Possible action agency ARI
- Develop/refine MANPRINT tools, techniques (\$20M)⁴
 - Possible action agency HRED/AMC

POM increase = \$60M for TOTAL LIFE CYCLE R&D

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¹ Research studies and analyses are conducted in stovepipes, e.g., how much enlisted bonus would have to be paid to attract smarter soldiers. The Army does not have the capability to conduct trade-off analysis across stovepipes (e.g., suppose we mandated MANPRINT [Manpower and Personnel Integration] so we would use less smart soldiers for some FCS tasks.)

² To best understand what capabilities will be needed in the FCS, we need to have a better understanding of how it will be employed and what its limitations and constraints will be. The best way to develop these concepts is through simulation-based acquisition. Toward that end, it is imperative that an initial virtual, distributed, man-in-the-loop emulation of the FCS be created so that what-if scenarios can be executed. This will allow the FCS developers to better understand what is needed, to examine alternatives, and to experiment with tactics, techniques, and procedures for the FCS. We can use this simulation to define Manpower & Personnel requirements and evaluate alternative training systems. It seems logical to use a collaborative effort between Defense Advanced Research Project Agency (DARPA) and the Army to accomplish this, given DARPA's interest in this project and the synergy of these two agencies in the initial effort to develop the FCS. Further, we recommend that this initial effort be undertaken as soon as possible in the very near term to achieve its maximum benefit. This research was also recommended by last year's ASB study.

³ A dominant organizational assessment technique used in industry is the balanced scorecard mechanism. Kaplan and Norton (*The strategy-focused organization*. Boston: Harvard Business School Press, 2001) indicate that 56% of the organizations in the U.S. are implementing this strategic management tool. One looks at financial perspective, a stakeholder perspective, an innovation and learning perspective, and an internal business perspective (O'Neil & Bensimon, Diamond, & Moore. (1999). Designing and implementing an academic scorecard. *Change*, 31(6), 32-40). Recently, that approaches has been applied to Human Resource Functions in industry (Becker, Huselid, & Ulrich. (2001). *The HR Scorecard*. Boston: Harvard Business School Press). Such a scorecard with goals, measures, and benchmarks would result in a more cost-effective HR community in the Army. Further, it would serve as a communication vehicle with the Army Leadership.

⁴ The Army's MANPRINT program needs to have resources to develop new methods, tools and techniques that could be applied, in an analytical manner, to the array of systems that will go into making up the Objective Force. It also needs to have dedicated analysts to carry out these analyses--as early in the system design process as possible--so as to have a positive impact on outcomes. The application of MANPRINT analyses during the early design stages of Comanche resulted in a documented \$3.8 Billion in cost avoidances.



ARMY MUST FUND NEEDED ANALYTIC WORK TO ANSWER THESE QUESTIONS

- How does FCS affect branch structure?
 - Lowest fighting level may be combined arms or multifunctional (tanker/artilleryman/airdefender/communication specialist)
- How do FCS Jobs/KSAs affect MOS structure?
- Can available enlisted soldiers handle very complex tasks (e.g., C4ISR) or will warrant officers or officers be required?
- If C4ISR system works at less than required capability, what's the back-up plan for Manpower/Personnel?
- Does Objective Force require Army officers with more advanced degrees, and if so, how do they get promoted?
 - Possible action agency FFRDC
- Impact: Lack of analytic work will affect successful fielding of FCS

POM increase = \$5M for analytic work, enables answers to these questions

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In our study, such issues arose again and again. We considered these issues outside of the scope and did not have the time during this four-month study to conduct a detailed analysis. It's recommended that such analysis be conducted. Such issues will affect the successful fielding of the FCS. The above analytic work could probably be funded with Project 6.5 monies.



PICK LOW-HANGING FRUIT NOW

- Recruit persons who attend college but who will not graduate¹
 - African American and Latino students are expected to increase their college going but completion rates are expected to remain relatively the same²
- Implement the Enlisted Personnel Allocation System
- Make MANPRINT mandatory for FCS
 - RAND³ contends that applying MANPRINT analyses to FCS design could result in reduction of categories I-IIIa non-prior service personnel of 10,000 a year. These could be replaced by category IIIbs, who are less costly to recruit and retain.
- Get Army M&P Issues into Office of Education Longitudinal Testing Program⁴
- Foster cooperative agreements between AMC and ODCSPER⁵
- Impact is immediate. A force multiplier but not free

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¹ Martin Orland, email. 3/30/01

² EPAS: A Method for Improving the Army's Classification System. The latest tool available to the Army for improving the classification process is the Enlisted Personnel Allocation System (EPAS). Designed to be a subsystem of REQUEST (Recruit Quota System), EPAS is a classification tool that optimizes the assignment of recruits to entry-level MOS. EPAS goes beyond the Army's present approach to person-job matching (i.e., identifying high priority MOS for which an applicant meets the minimum Aptitude Area composite score qualifications). In contrast, EPAS identifies those MOS in which the individual is likely to perform with the greatest effectiveness, while meeting the Army's accession goals and filling critical MOS. The EPAS tool was initially developed through a 4-year R&D project conducted by ARI in the 1980s (Konieczny, F.B., Brown, G. N., Hutton, J., & Stewart, J.E. (1990) *Enlisted Personnel allocation system: Final report* (Technical Report 902). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences). A personal computer-based EPAS (PC-EPAS) prototype was created and evaluated with laboratory simulations of the Army's classification process in FT 1998 (Greenston, P.M., McWhite, P.B., Mower, D., Walker, S.W., Lightfoot, M.A., Diaz, T., & Rudnick, R. (in preparation). *Toward optimized classification in the U.S. Army: Development of the enlisted personnel allocation system (PC-EPAS)* (Study Report). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences). Based on the positive results of the 1998

study, ARI developed an operational version of EPAS in FY 2000, which will be field tested in FY 2001. (SOURCE: Lightfoot, M.A., Ramsberger, P.F., & Greenston, P.M. (2000, August). *Matching recruits to jobs: Enlisted Personnel Allocation System* (Special Report 41). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. p. 11.)

³ Currently, MANPRINT is an optional program. It should be made mandatory with resources added to accomplish policy and oversight. RAND briefing 3 April 01.

⁴ The Army will need information on the development of skills, knowledge and abilities of youth and young adults in the civilian population that have relevance for the Objective Force, as well as information on propensity to enlist. Strategies for obtaining such information from the Office of Educational Longitudinal Testing Program need to be developed.

⁵ AMC and DCSPER or HR/Personnel Mission Area do not have cooperative agreements to support the personnel info technology R&D, modernization, or recapitalization. This is a void in AMC's Army support structure. The Personnel community (Guard, Reserve, and Active) gets minimal benefit from AMC wide software management efforts. AMC has programs to support the Commander, S2-G2, S3-G3, S4-G4, Fire Support (FA and Air Defense), all maneuver, and most classes of supply (repair parts, ammo, fuel, etc). There is no AMC program to benefit the S1-G1. Given transformation, it is time to fix this condition.



WHAT WE WANT YOU TO REMEMBER

- Distributed, collaborative, network centric force requires emphasis on different Knowledge, Skills and Attributes (KSAs) due to very complex tasks at lower echelons
- There is no foundation for Manpower & Personnel for the Objective Force with the present R&D investment
- How do I fix the situation
 - Pick low-hanging fruit; focus and fund (\$5M) analytic work
 - Adequately fund Manpower & Personnel research — to conduct balanced, longer term research in the recommended areas (\$150M short over POM cycle)
- This R&D investment will enable accomplishment of FCS, improve readiness and combat effectiveness

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Given the nature of the FCS, it is expected that different personnel knowledge, skills and attributes (KSAs) will be needed. Given the very low levels of R&D funding in Manpower & Personnel, there is no foundation for such a force. Without an infusion of R&D funds now, the Army will not be ready for the FCS. The funding estimates represent our expert judgment of what the type of research we suggest will cost. They are probably accurate within 10-20%.

This R&D investment will enable accomplishment of FCS, improve readiness and combat effectiveness. We must invest in people.



SUMMARY ACTION LIST

| Action | Cost |
|----------------------------|------|
| • Fund R&D | 150m |
| • Fund analytic work | 5m |
| • Pick low hanging fruit | TBD |
| • Action agency DCSPER/ARI | TBD |

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APPENDIX A

TERMS OF REFERENCE



TERMS OF REFERENCE (TOR)

- Support 2001 Summer Study on issues relevant to the soldier in the objective force.
- Review current and future requirements, identify areas needing research, and finally estimate funding needed to support the R&D. This Study will assist the Army in focusing priorities for research, development and acquisition accounts in the areas of Manpower and Personnel.
- Should be composed of multiple investigations leading to an integrated set of recommendations. This work is to be guided by, but not limited to, the following:
 - Investigate the demographic characteristics of the soldier in 2015
 - Assess what can he or she know or do.
 - Investigate the projected knowledge, skills, attitudes for Future Combat Systems tasks
 - Assess the match/mismatch between the projected skill set of soldiers and required skills based on FCS tasks.
 - Assess the Army R&D that is going on in the manpower and personnel area
 - Investigate university/industry R&D in the manpower and personnel area.

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These were our Terms of Reference. The Army DCSPER fully supported this special study to investigate these issues and whether there is adequate funding for 6.1, 6.2, and 6.3A programs in this area. Such funding should provide for appropriate research in soldier qualifications, skills, knowledge, attitudes etc., to meet quality, quantity, and ethnic and gender diversity to fill Army requirements for FCS in 2010-2025.

This Special Study was part of the Summer Study 2001, “[The] Objective Force Soldier / Soldier Team,” chaired by Dr. Bob Douglas.

APPENDIX B

PARTICIPANTS LIST

PARTICIPANTS LIST

ARMY SCIENCE BOARD
2001 SPECIAL STUDY

MANPOWER AND PERSONNEL FOR SOLDIER SYSTEMS IN THE OBJECTIVE FORCE

Study Co-Chairs

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President and CEO
Ralph Consulting

Dr. Harold F. O'Neil
Professor of Educational Psychology and
Technology
University of Southern California

Panel: ASB Members and Consultants

MG Charles F. Drenz
President
C.F. Drenz and Associates

Dr. Mark Hofmann
President
COLMAR L.L.C.

Dr. Michael Freeman
Director, Army Programs Training
Computer Sciences Corporation

Ms. Susan Lowenstam, Esq.
Attorney at Law

Dr. Valerie Gawron
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LTG John E. Miller (USA, Ret.)
Executive Director, Learning Solutions
Oracle (Government)

Sponsor

LTG Timothy Maude
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APPENDIX C

ACRONYMS

Acronyms

| | |
|----------|--|
| ADCSPER | Assistant Deputy Chief of Staff for Personnel |
| AMC | Army Materiel Command |
| AMCOS | Army Military-Civilian Cost System |
| ARI | Army Research Institute |
| ASA | Assistant Secretary of the Army |
| ASB | Army Science Board |
| ASVAB | Armed Services Vocational Aptitude Battery |
| BDA | Battlefield Damage Assessment |
| C4ISR | Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance |
| CSA | Chief of Staff of the Army |
| DARPA | Defense Advanced Research Projects Agency |
| DCSPER | Deputy Chief of Staff for Personnel |
| EPAS | Enlisted Personnel Allocation System |
| FA | Field Artillery, Functional Area |
| FCS | Future Combat System |
| FY | Fiscal Year |
| GAO | General Accounting Office |
| HR | Human Resources |
| IRT | Independent Review Team |
| KSA(s) | Knowledge, Skills and Attributes |
| M&P | Manpower and Personnel |
| MANPRINT | Manpower and Personnel Integration |
| MOS | Military Occupational Specialty |
| NAEP | National Assessment of Educational Programs |
| NCES | National Center for Education Statistics |
| NCO | Non-Commissioned Officer |
| OCAR | Office of the Chief of the Army Reserve |
| ODCSPER | Office of the Deputy Chief of Staff for Personnel |
| PC-EPAS | Personal Computer - Enlisted Personnel Allocation System |
| PE | Program Elements |
| POM | Program Objective Memorandum |
| PPBES | Planning, Programming, Budgeting, and Execution System |
| QDR | Quadrennial Defense Review |
| R&D | Research and Development |
| SIPP | Survey of Income and Program Participation |
| TIMSS | Third International Mathematics and Science Study |
| TOR | Terms of Reference |

APPENDIX D

KNOWLEDGE, SKILLS AND ATTRIBUTES - DEFINITIONS



Definitions of Required KSAs – Ref. Slide (KNOWLEDGE, SKILLS AND ATTRIBUTES HIGHER REQUIREMENTS FOR FCS THAN CURRENT FORCE)

- **Currently part of ASVAB**
 - General Science, Arithmetic Reasoning,
 - Electronic Information, Coding Speed, Numerical Operations
- **Not currently measured**
 - Dynamic Visualization/ Pattern Recognition
 - Collaboration/Teamwork
 - Adaptability/Creativity
 - Situational Awareness
 - Conscientiousness/Dependability
 - Technological Fluency
 - Team Competencies

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Part of ASVAB

General Science: Knowledge of physical and biological sciences.

Arithmetic Reasoning: Solving word problems that emphasize reasoning rather than mathematical knowledge.

Electronics Information: Knowledge of electricity, radio principles and electronics. Coding Speed: Ability to quickly and accurately locate numbers in a table. The Numerical Operations test consists of 50 simple mathematical computations.

Not Currently Measured

Dynamic Visualization

This ability implies that people are capable of forming mental images of dynamic objects that are analogous to the objects being presented and that these mental images can be “viewed” to make decisions and answer questions about a hypothetical referent. Such ability is useful for careers in engineering, physical science, or art, or assessment in C4ISR. (Duesbury, & O’Neil. (1996). Effect of type of practice in a computer-aided design environment in visualizing three-dimensional objects from two-dimensional orthographic projections. *Journal of Applied Psychology*, 81, 249-260.)

Collaboration/Teamwork:

| | |
|--------------------------------------|---|
| Adaptability (situational awareness) | Recognizing problems and responding appropriately |
| Communication | Exchange of clear and accurate information |
| Coordination | Organizing team activities to complete a task on time |
| Decision making | Using available information to make decisions |
| Interpersonal skills | Interacting cooperatively with other team members |
| Leadership | Providing structure and direction for the team |

(O’Neil, Wang, Chung, & Herl. (2000). Assessment of teamwork skills using computer-based teamwork simulations. In O’Neil & Andrews Eds.), *Aircrew training and assessment* (pp. 245-276). Mahwah, NJ: Erlbaum.)

“For our purposes, a *team* is defined as a distinguishable set of two or more people who interact, dynamically, interdependently, and adaptively toward a common and valued goal/objective/mission, who have each been assigned specific roles or functions to perform, and who have a limited life-span of membership.” (Salas, E., Dickinson, T. L., Converse, S. A. & Tannenbaum, S. I. (1992). Toward an understanding of team performance and training (pp. 3-29). In R. W. Swezey & E. Salas (eds.), *Teams: Their training and performance*. Norwood, NJ: Ablex Publishing Corporation.



Definitions of Required KSAs – Continued

- **Currently part of ASVAB**
 - General Science, Arithmetic Reasoning,
 - Electronic Information, Coding Speed, Numerical Operations
- **Not currently measured**
 - Dynamic Visualization/ Pattern Recognition
 - Collaboration/Teamwork
 - Adaptability/Creativity
 - Situational Awareness
 - Conscientiousness/Dependability
 - Technological Fluency
 - Team Competencies

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Not Currently Measured (Cont.)

Adaptability/Creativity

"Adaptability may not be a single attribute, but rather a combination of attributes. Pulakos, Plamondon, and Kiechel (1997) described a project being conducted for the Army Research Institute which is examining cognitive abilities and such non-cognitive characteristics as openness, flexibility, and tolerance of ambiguity as predictors of adaptive performance." (Rumsey (1999). Officer selection in the 21st century (pp. 9-1 to 9-10). In Officer Selection. RTO Meeting Proceedings 55, North Atlantic Treaty Organization. Creativity refers to the potential to produce novel ideas that are task-appropriate and high in quality (p. 360; Sternberg, 2001, Amer Psychol, 56, 360-362).

Situational Awareness

"the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future." (Endsley, M. (1988). Situation awareness global assessment technique (SAGAT) (pp. 789-795). In Proceedings of the Aerospace and Electronics Conference. New York: IEEE.

Conscientiousness/Dependability

"Characteristic amount of behavioral self-control. The highly conscientious person is dependable, planful, well organized, and disciplined. This person prefers order and thinks before acting." Peterson, N. G. (ed.) (1987). Development and field test of the Trial Battery for Project A. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Pattern Recognition

"The ability to recognize and match visual patterns. (Auditory pattern recognition is the ability to recognize spoken words." The author goes on, using computer processes to explain this concept: "Pattern recognition basically works by having the computer seek out particular aspects of the character (assuming it's pattern recognition for reading words) and then having the computer compare what it finds to what's in its database of patterns." (Newton, H. (1996). Newton's Telecom Dictionary. New York: CMP Books, p. 517.)

Technological Fluency

The term "technological fluency". . . was generally described earlier by Papert (1996). . . [O]ur definition [is] that technological fluency denotes an individual's well-developed skills, propensities, and knowledge that are required to use, design and develop electronic and bionic hardware and software to enhance various aspects of life. (Baker & O'Neil. (in press). Technological fluency: Needed skills for the future. In O'Neil & Perez (Eds.), *Technology applications in education: A learning view*. Mahwah, NJ: Erlbaum.)

Team Competencies

Canon-Bowers and her colleagues indicate that team competencies can be thought of as the requisite knowledge (e.g. principles and concepts underlying a team's task performance), skills (e.g. psychomotor and cognitive behavior necessary to perform the team task correctly), and attitudes (e.g. collective orientation) that result in effective team performance, while competencies can be generic or specific to a team or a task (Cannon-Bowers et al. 1995; Cannon-Bowers & Salas, 1997, 1998). To accomplish this, team members must share a common sense of the task and similar mental models to coordinate activities effectively. Using this reasoning, team members require knowledge of the task, the environment, and their team members to be effective.

APPENDIX E

BACKGROUND / BACKUP SLIDES



FCS MANPOWER, PERSONNEL, TRAINING ANALYTIC WORK

- Army Science Board Summer Study (Training). O'Neil, H. F., Jr., Drenz, C., Lewis, F., et al. (2000). *Technical and tactical opportunities for revolutionary advances in rapidly deployable joint ground forces in the 2015-2025 era*. Army Science Board-1999-2000 Summer Study.
COMPLETED JULY 00
- Leadership IRT. Miller, J., & O'Neil, H. F. (2001). *Leader (leadership) development independent review team findings and recommendations*. Presentation Independent Review Team to Dr. A. Michael Andrews, Deputy Assistant Secretary of the Army (Research & Technology), Washington, DC, February 7.
COMPLETED FEBRUARY 01
- Army Science Board Special Study (Ralph J. & O'Neil, H.F.). *Manpower and Personnel for Soldier Systems in the Objective Force*
COMPLETED 25 JUNE 01
- Army Science Board Summer Study (Douglas et al.). *Soldier Systems in the Objective Force*
TO BE COMPLETED AUGUST 01



DATA ACQUISITION

- EXAMPLE BRIEFS TO DATE:
 - DEFENSE: DMDC
 - ARMY: DCSPER, TRADOC, ARI, ARL, WRAIR, USAREC, PM SOLDIER SYSTEMS, USARNG, USAR, AMC
 - FFRDC: RAND/ARROYO, IDA
- LITERATURE REVIEWS: USN, USAF, ACADEMIA, INDUSTRY
- Civilian sector information: Dr. Marty Orland, Office of Education Research and Improvement

ASB M&P 23 June 01 v9B Slide 4



WHAT IS WELL-BEING?



**Encompasses and Expands
on the Concept
of “Quality of Life”**

Definition:

The personal -- physical, material, mental, and spiritual -- state of Soldiers, retirees, veterans, civilians, and their families that contributes to their preparedness to perform and support the Army’s mission.

A Condition that results from A System of Programs

- Encompasses the entire Army Community
- Links individual needs with Army needs
- Acknowledges the entire breadth of individual aspirations
- Recognizes the effect of intangibles
 - values, command climate, etc.
- Holistic Approach to Well-Being
- Integrates all associated programs
- Establishes goals, strategies and objectives
- Uses metrics to measure success
- Incorporates a marketing plan
- Synchronized with PPBES, QDR, etc.

ASB M&P 26-107M4Y1 01997 SBddr55

“The Army’s readiness is inextricably linked to the well-being of its people — soldiers, civilians, retirees, and their families. The most significant investment in the Nation’s security is investing in them. We must provide adequate housing, schools, and medical and dental care with a quality and access comparable to society at large. Our support structures must provide soldiers and families the resources to be self-reliant both when the force is deployed and when it is at home station. . . .” Source: CSA’s Intent for Well-Being.



SCHEDULE

Except for the Plenary Meetings all meetings were held at PEOSTAMIS Ft Belvoir VA. Planned Meetings to date are below:

| <u>DATE</u> | <u>PURPOSE</u> |
|---------------|--|
| x January 26 | Introductions, TOR, and Planning |
| x February 23 | Briefings, Group Discussions, Planning, & Status |
| x March 5 | Individual Group Meetings |
| x March 13-15 | Provide status report to the 2nd ASB Plenary Session |
| x April 2-3 | Briefings, Group Status Reports, & Wrap up |
| x May 3 | Status report to ADCSPER |
| x May 16-17 | Presentation of draft report to the 3rd ASB Plenary Session. Fort Bragg NC; Red Team |
| XJune 19 | Briefing to DCSPER |
| July 16-26 | Summer Study writing session/outbrief to CSA, Beckman Ctr. Irvine CA |
| x = Completed | |

ASB M&P 23 June 01 v9B Slide 6

This is our current schedule. Recall this is a short, four-month research effort with meetings mainly at Ft. Belvoir and with a minimum travel. We made maximum use of electronic means. We are building on the findings of the training panel Summer Study 2000 and recent IRTs for Dr. Mike Andrews, the Deputy ASA for Acquisition, Logistics and Technology, and the present ARI R&D program. We briefed our sponsors in June. Note our next formal meeting will be at the Beckman Center July 16-26, 2001.



SPECIAL STUDY FRAMEWORK

| TOR Group | ✓ = Lead | |
|--|--|---|
| A: Demographics and Skill Levels: Today and Future | ✓Dr. Zita Simutis Col Ron Logsdon Mr. Ralph Shaw | Col(R) Neil Grotegut Col (R) Kurtz |
| B: Very Complex Tasks and Projected Skills for FCS | ✓Dr. Mike Freeman Mr. Ralph Shaw Col Dave Raes | MG(R) Chuck Drenz. Dr. Bob Holz Col Barbara Lee |
| C: Current R&D and R&D in Universities & Industry | ✓Dr. Mark Hofmann MG(R) Chuck Drenz Dr. Harry O'Neil | MG Sue Dueitt Dr. Susan Lowenstam |

ASB M&P 23 June 01 v9B Slide 7

This is the Panel breakout into study groups that provided the investigations and recommendations that comprise the study results. These groups were encouraged to work independently and in concert during the February–May 2001 period so as to wrap up their findings and recommendations for our meetings. We integrated their findings and went final for a draft report to the May ASB Plenary session which included a red team review. We then briefed the DCSPER in June.

APPENDIX F

MANPOWER AND PERSONNEL BRIEFING TO ARMY CHIEF OF STAFF

This study was selected for inclusion into the 2001 ASB Summer Study "The Objective Force Soldier / Soldier Team" and was briefed as one of ten Panel Reports to the Chief of Staff of the Army and other VIPs at the conclusion of the 2001 Summer Study Session.

The 2001 Summer Study Report was published in three volumes:

Volume I - Executive Summary

selected slides and text from all 10 panels

Volume II - Science and Technology Challenges

Fightability, Weight, Power, S&T Strategy, and Affordability

Volume III - Background and Context

Threats, Concepts, Analysis, Manpower & Personnel and Sr. Officer Observations

The study report can be found in the studies section of the Army Science Board website:

<http://www.saalt.army.mil/sard-asb/>

The briefing to the Chief of Staff and other VIPs consisted of the following slides. This briefing with annotated text is in Volume III - Background and Context.



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2001

Manpower and Personnel for Soldier Systems in the Objective Force

Mission Statement

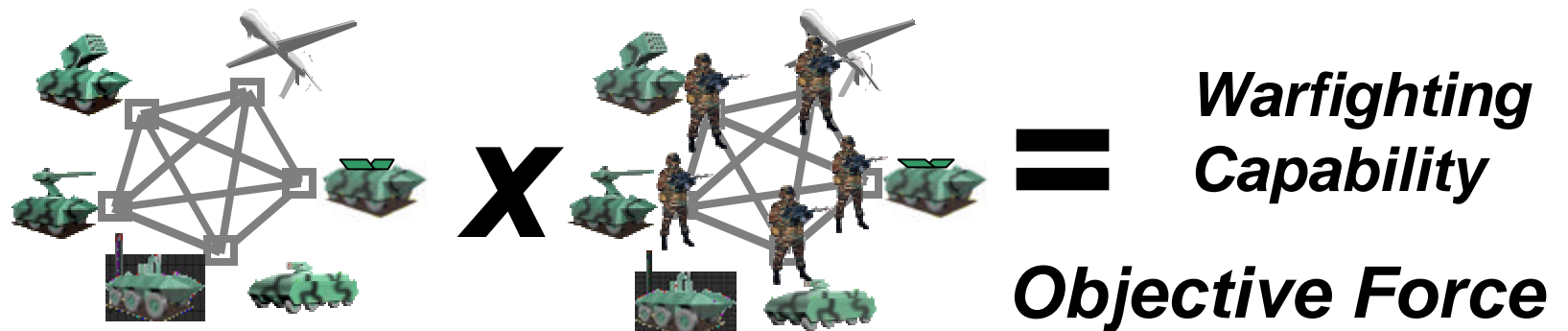
To focus, prioritize and recommend research and development on soldier knowledge, skills and attributes to meet Army requirements for the Objective Force

Co-Chairs: Dr. Harry O'Neil and BG(R) Jim Ralph

Sponsor: The DCSPER, LTG Timothy Maude



What is the Operational Value of Good Soldiers?



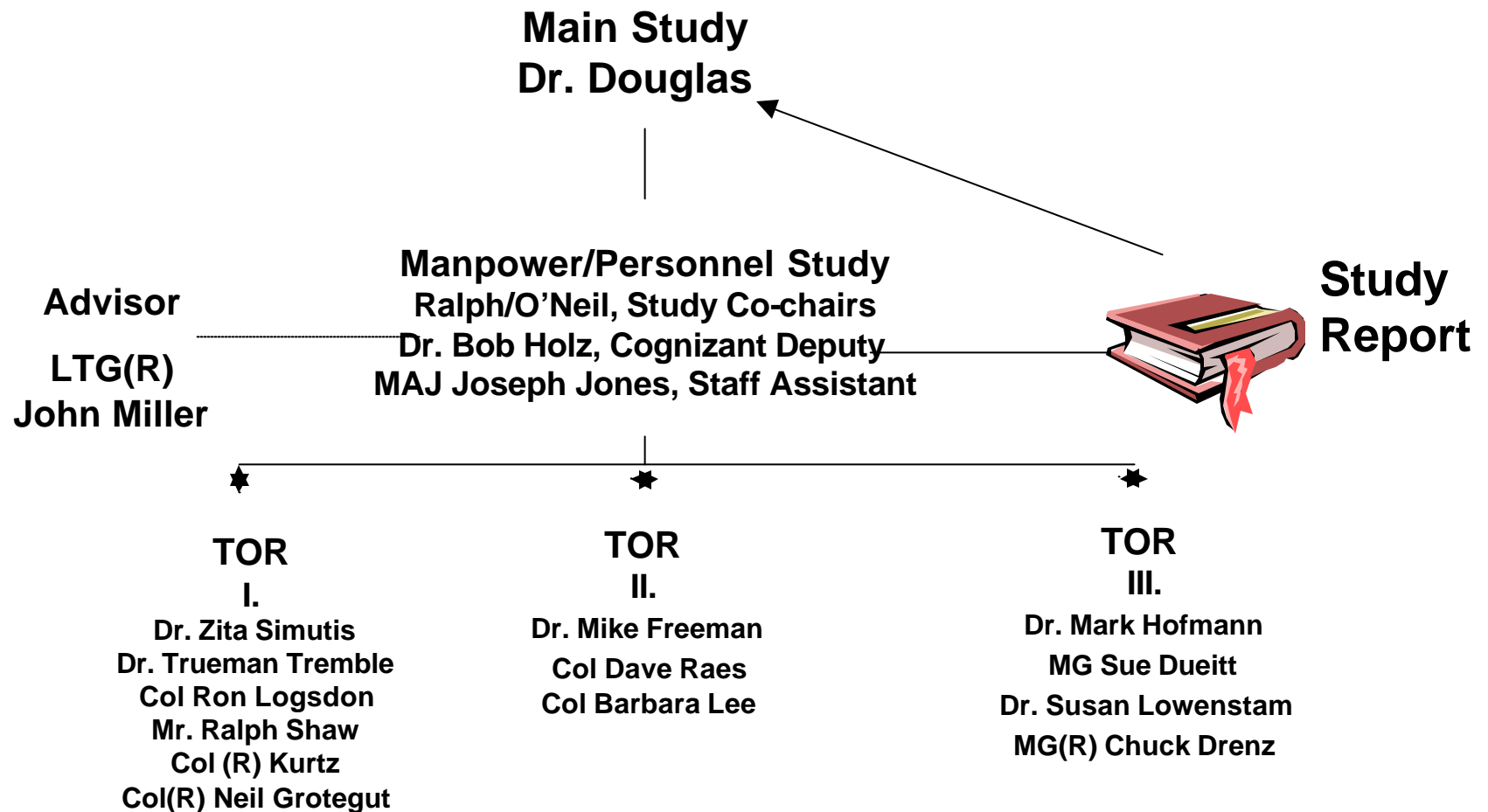
Results in achieving the 10X improvement

Agenda

- **Background of study**
- **Terms of reference (TOR)**
- **Results of study (TOR 1, TOR 2, TOR 3)**
- **Recommendations**
- **What we want you to remember**



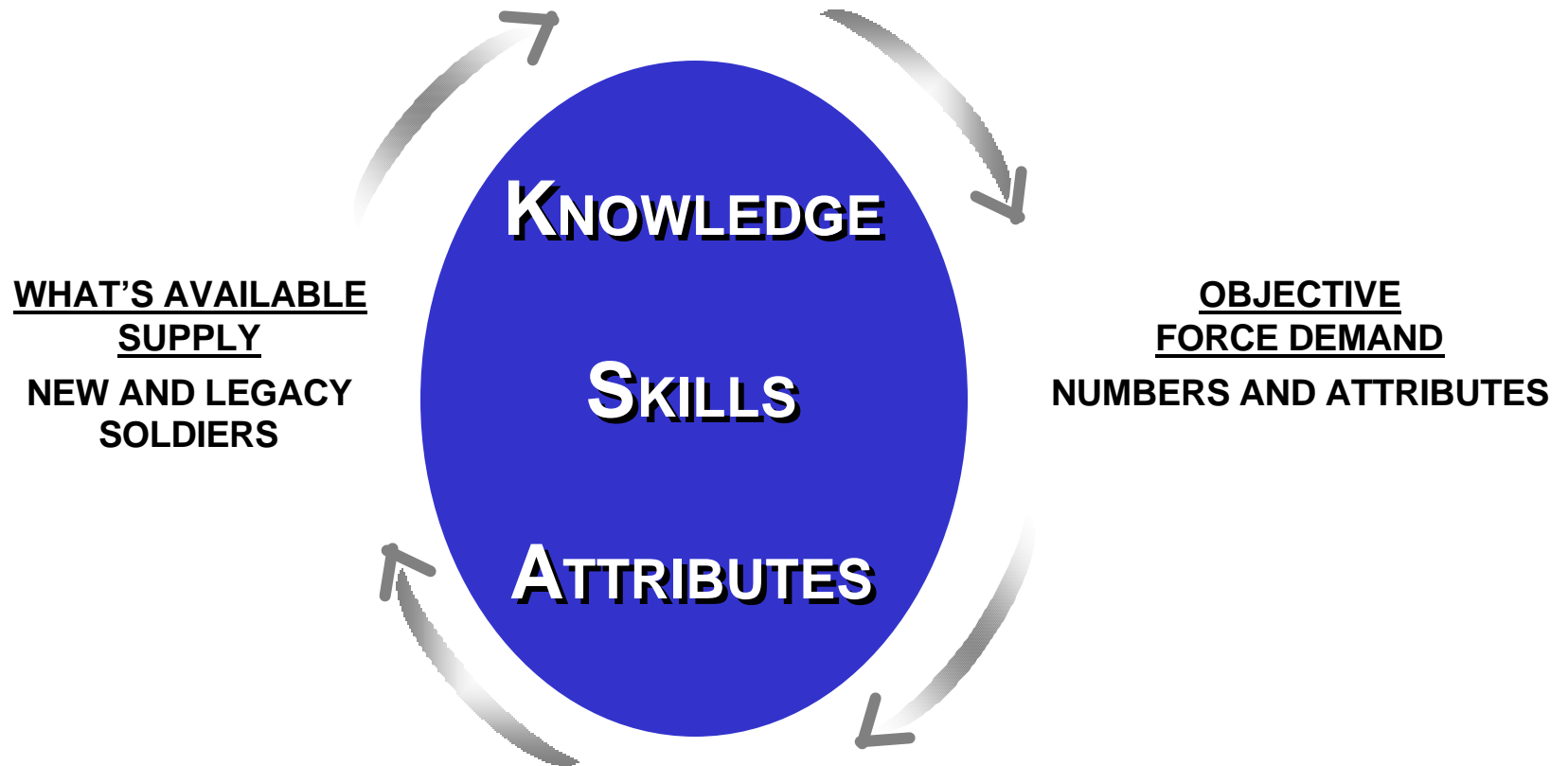
Study Organization





Study Schematic

How Do We Meet the Knowledge, Skills, and Attribute Requirements of the Objective Force?



How will we acquire, assign, and sustain soldiers?



Terms of Reference Simply Stated

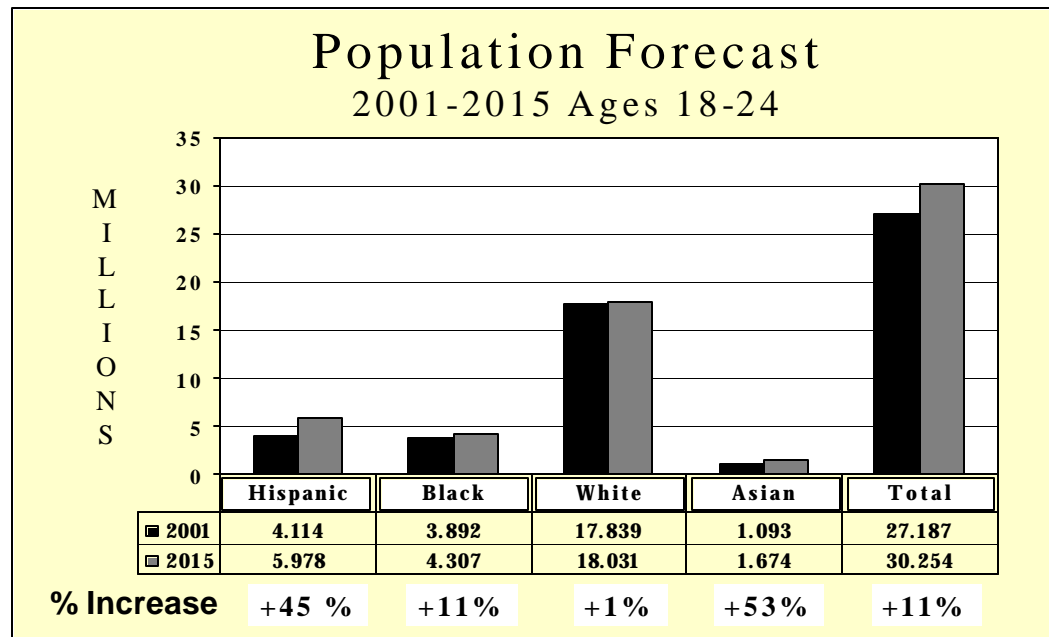
Manpower and Personnel

- **Demographic Characteristics:**
 - Who Will Be Available
 - What Attributes Will They Have
- **Attribute Requirements:**
 - What Knowledge, Skills, Attributes Will Be Needed
- **Research and Development Requirements**
 - Is R&D Effort Adequate To Permit the Army to Acquire
 - Assign, and Sustain Personnel for the Objective Force



Demographic Characteristics (TOR1)

- TOR1: Demographic Projections
 - Minority youth population will increase, especially Hispanics



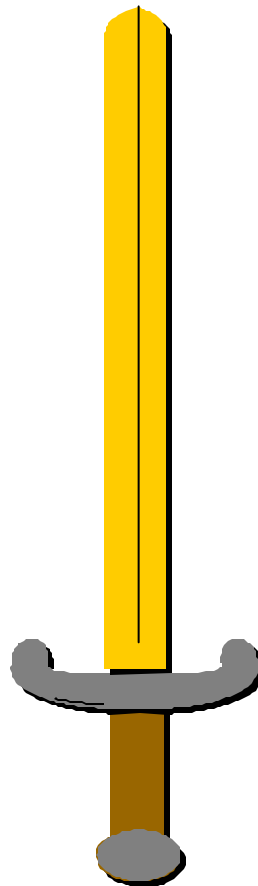
- By the 12th grade in 2010, he or she will be
 - *Showing equivalent academic achievement earlier generation U.S. 12th graders
 - *National Assessment of Educational Progress trends
- As in past, comparing very unfavorably academically to children from other nations
 - *Third International Science and Mathematics Study



Future Soldiers Will Be Digital Learners — Double-Edged

Pro

- Multiprocessing
- Extensive effort on enjoyable tasks
- Computer fluency
- Bias to action



Con

- Varied attention span
- Some Army tasks are not enjoyable
- Reflection is not a tendency



Skill Summary

- **Skill Level Projections**
 - **Academic achievement will change very little from 2001 to 2010**
 - * NAEP scores have increased less than .20 standard deviation units across all testing domains since 1980
 - **Technology familiarity will increase due to home and school computer use**
 - **AFQT scores will remain stable from 2001 to 2010**
 - * Since 1985, Mean AFQT has ranged from 57.79 to 59.32, only 1.53 points
 - **High school graduation and college continuation rates will remain high in 2010**
 - * Current high school graduation rates are 93.0% (white) and 88.7% (black). A lower Hispanic rate, 61.6%, may reflect recent immigration
 - **Bottom Line: Potential recruits will be similar in skills to today's recruits**

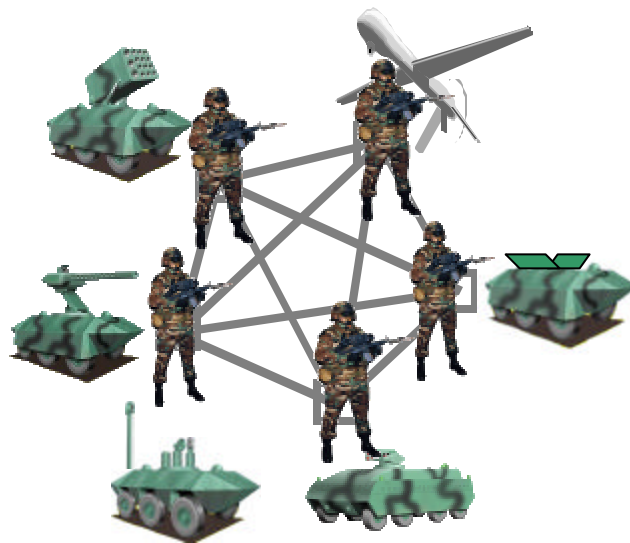


Terms of Reference (2)

Projected Skills and Match/Mismatch

Objective Force:

Distributed, internetted, collaborative team of teams engaging in very complex tasks



Tenets

- See First
- Understand First
- Act First
- Finish Decisively



Examples of Very Complex Tasks

- Manage C2 of direct and indirect fire robotic systems
- Conduct teleoperated robotic navigation
- Control anti-jamming networks
- Ensure network security for C2 of distributed robotic systems
- Control robotic sensors

~15% of tasks can be described as very complex



Knowledge, Skills and Attributes Different Requirements for Objective Force

- **Currently part of ASVAB**
 - Word Knowledge, Paragraph Comprehension, Arithmetical Reasoning, Math Knowledge (AFQT)
 - General Science, Electronic Information
- **Not currently measured**
 - Dynamic Visualization/ Pattern Recognition
 - Collaboration/Team Competencies
 - Adaptability/Creativity
 - Situational Awareness
 - Conscientiousness/Dependability
 - Technological Fluency
 - Numerical Operations, Coding Speed



Knowledge, Skills and Attributes Match/Mismatch

- **Assess the match/mismatch between the projected skill set of soldiers and required skills based on Objective Force tasks**
- **Can we characterize the 5th, 50th, and 95th Percentiles**

**Most of KSAs are not addressed by current measures
– Will have to be created, Thus:**

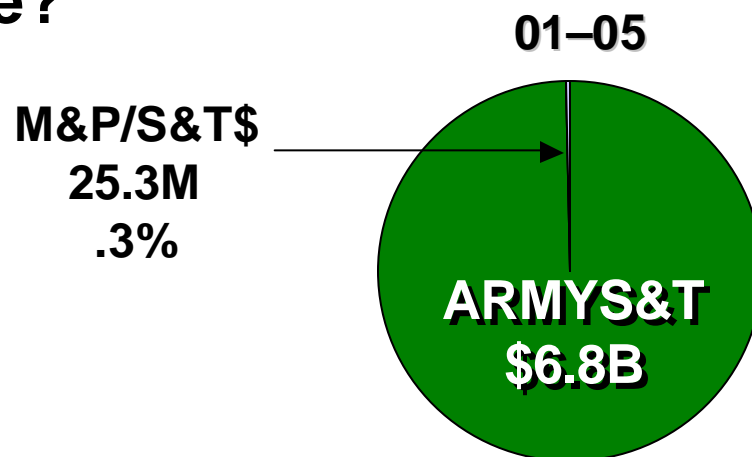
Cannot characterize the 5th, 50th, 95th percentiles without further research in measures



Manpower & Personnel/ Science & Technology (TOR 3)

The question:

Is Manpower and Personnel S&T funding adequate to provide research-based tools, techniques, procedures and information needed to meet the soldier acquisition, assignment and sustainment requirements of the objective force?





Good News

- **Manpower and Personnel R&D efforts (ongoing and planned) are solid but will not meet the needs of the Objective Force**
- **Time is available to conduct Manpower and Personnel R&D to meet the needs of the objective force — must start now**
- **There is sufficient basic research (6.1) to have confidence to conduct the applied R&D (6.2/6.3) — no new breakthroughs required**
- **Significant savings from timely investment can offset Manpower and Personnel R&D costs for the Objective Force**



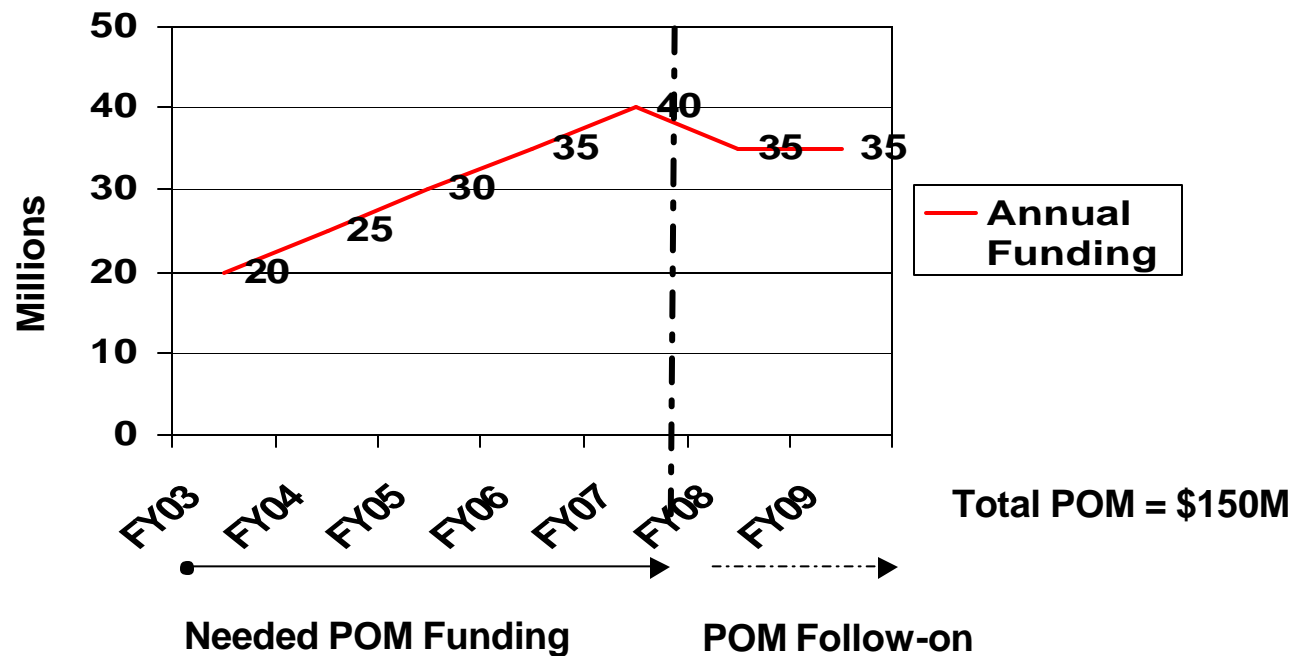
Significant Cost Savings

- **Small changes lead to big savings due to size of manpower pool**
 - **Back of envelope calculation indicates potential 5 year savings of \$180M if 5% cut in attrition rates**
 - * **Annual cost of attrition = \$719,640,000**
 - Number of accessions (71,749) X
 - attrition rate (.368) X
 - cost of each attrit (\$27,255)
 - * **5% reduction in attrition over POM = \$180M**
 - 720M X 5% X 5yrs = \$180M
- **Additional advantages in improved readiness and combat effectiveness**



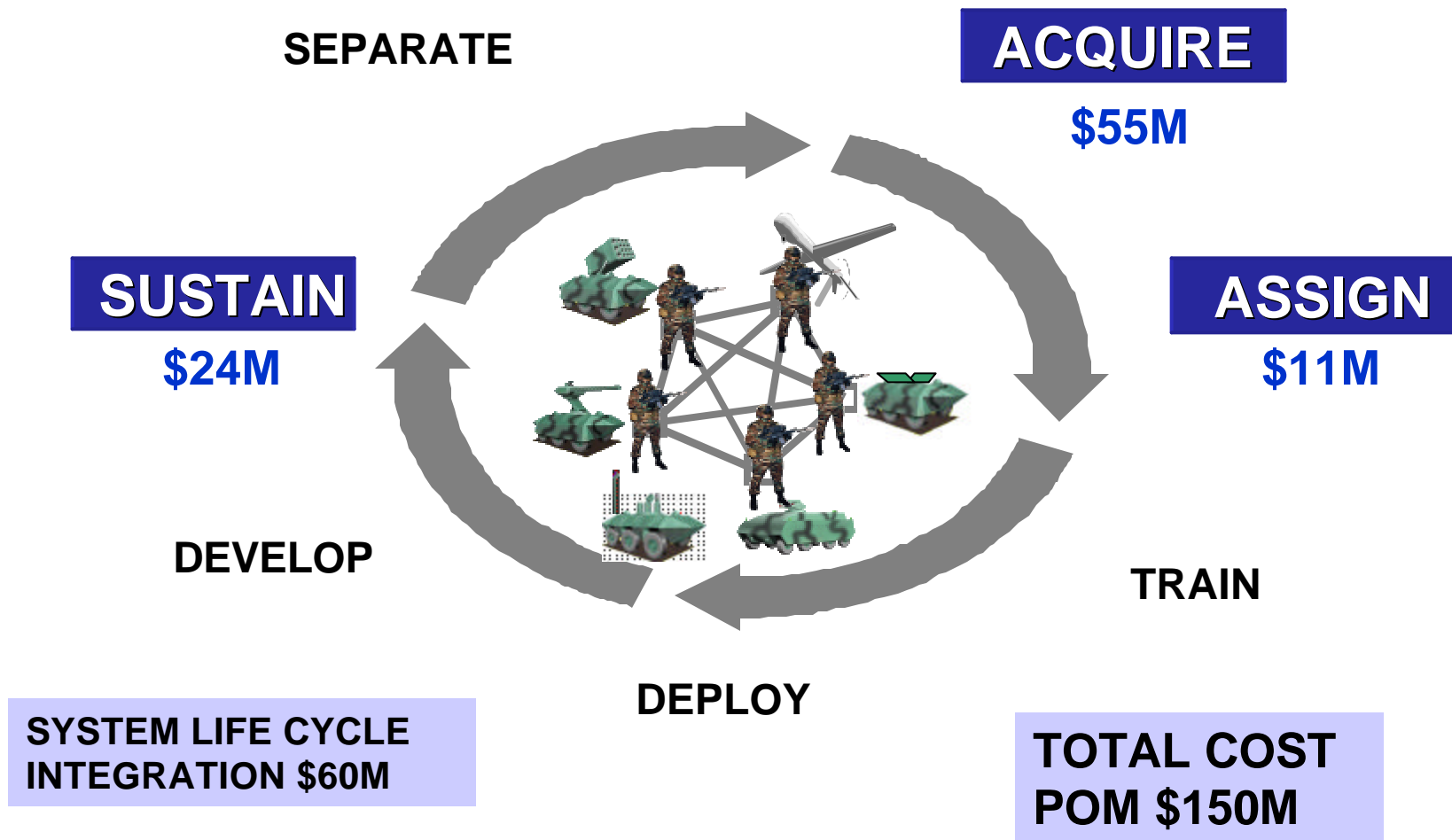
Bad News

- Little relevant 6.2/6.3 industry or academic research exists
- Lots of opinion but little hard data on what skills will be needed, how to best assign those recruited, and what factors will sustain
- Need to fund R&D — add an additional \$150M in POM cycle





Soldier Life Cycle System





To Improve Objective Force Life-Cycle Processes

- **Improve Acquisition, Recruitment & Assignment Process - \$55M**
 - Revise ASVAB
 - Test youth population on very complex tasks
 - Determine Cultural Characteristics of Hispanics to Improve Process
- **Improve Assignment Process - \$11M**
- **Improve Sustainment & Retention Process - \$24M**
 - Cost Effectiveness of Well-Being Factors
 - Trust in Robots

POM Increase = \$90M



To Improve Soldier Systems Life-Cycle Integration

- **Improve Total Force R&D Life-Cycle**
 - **Develop Trade Off Models (\$10M)**
 - * **Selection (recruit smarter people) vs. Training (train to be smarter) vs. Human Factors (design simpler interfaces) vs. Medical (develop a smart pill)**
 - **Develop Simulations for Acquire/Sustain Functions (\$25M)**
 - **Develop MANPRINT Tools (\$20M)**
 - **Develop Manpower & Personnel Scorecard (\$5M)**

POM Increase = \$60M



Immediate Actions

- **Continue to recruit persons who attend college but who will not graduate**
- **Make MANPRINT factors mandatory for evaluation in Objective Force acquisition**
 - **Rand Study**
- **Continue to foster cooperative agreements between AMC and ODCSPER**
- **Impact is immediate.**



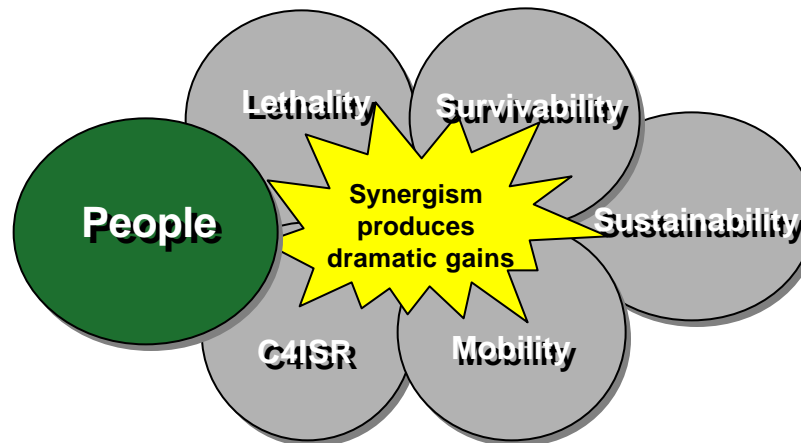
What We Want You To Remember

- Objective Force will require soldiers with different Knowledge, Skills and Attributes due to very complex tasks at lower echelons
- Present R&D does not provide the foundation for Manpower & Personnel
- *Adequately funding and focusing Manpower and Personnel R&D investment will enable the Objective Force*



Bottom Line

- Adequately fund Manpower & Personnel research (\$150M short over POM cycle)



APPENDIX G

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